

F-14 TOMCAT

in action



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in action



by Lou Drendel



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[Cover] F-14A Tomcat of VF-84 fires a Phoenix Missile, as contrails of two other Phoenix streak upward. Phoenix flight profile will take it high above it's target, before final guidance brings it down on it's quarry.



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Tom Hayden	Hana Rademann
Jim Sullivan	Bob Lawson
Ken Buchanan	Don Logan
Duane Kasulka	
Dr. C. Eddy	

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49 NEW MALDEN WAY
NEW MALDEN, SURREY
KT3 6EA, ENGLAND

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Variable Sweep Is for the Birds!

Ages and ages ago, Mother Nature outfitted birds with variable sweep wings. Ever since, birds have made good use of these wings, extending them for quick turns, energy-conserving gliding and short landings... sweeping them rearward for high speed diving, and other fancy wingwork. All in all, the variable sweep bird seems to have been a pretty solid design as there's never been a need for product improvements or model changes.

Was it something she just lucked into? Was it the result of extensive research and prototyping? Or was it just the natural thing to do?

We're sure it was the latter but how could we verify it? We found that if the run-of-the-mill, everyday bird had been equipped with a fixed wing, most or all of the following would be true of his characteristics:

- * he would be heavier
- * he would need more food
- * he wouldn't turn as well
- * he wouldn't be able to go as far
- * he would land faster
- * he would need a bigger nest
- * he would cost more (if it were possible to cost account a bird)



We must admit that when it comes down to our variable sweep wing capabilities, TOMCAT is really a "Copycat"....We just hope that Mother Nature understands that copying is the sincerest form of flattery.

We agree. Variable Sweep is for the birds...Naturally!
Grumman Aerospace Corporation

Introduction

"The F-14 Tomcat is the ultimate air-combat weapons system."...So goes the opening line of the Grumman Aerospace Corporation's information sheet on the Tomcat. Parochial as it may seem, this is a fair assessment of the F-14, for the Tomcat has bridged the gap from yesterday to tomorrow, in aerodynamics and avionics.

Even before the Tomcat flew, it was in a battle for survival, as the full wrath of anti-military congressional critics was directed at each new weapons system proposed in the waning months of the Vietnam War. That it was born of the abortive F-111B, which was to have been the Navy version of the F-111A, no TFX, did nothing to smooth the bumpy road from design to fleet introduction.

The Navy was never convinced that the F-111B could fulfill the fleet air defense assignment, but then Secretary of Defense Robert McNamara insisted upon concurrent development of both A and B versions of the F-111, citing the illusory benefits of "commonality"...an airplane for all seasons, services, and missions. The F-111B was built, rolling out of Grumman's factory in 1965. What had been evident on paper was proven conclusively during testing of the F-111B. It was simply not suitable for carrier operations. It was too heavy, 70,000 lbs. versus the max of 50,000 the Navy had specified for the airplane it wanted. It was not maneuverable enough. (The Vietnam War had proven that interceptors could be forced into an air superiority situation.) Angles of attack for coming aboard made it almost impossible to see the carrier, and all that extra weight taxed the existing arrester gear to the breaking point. It was patently obvious to the Navy, if not to McNamara and his "whiz kids", that the F-111B was a dead end. When McNamara left DOD, the Navy promptly funded money to Grumman for advanced fighter studies, hoping to come up with a design that could replace the F-111B when the time came.

The time came in May, 1968, when Congress refused to come up with more money for the F-111B program. By that time, the Navy had in hand two proposals from Grumman, designated VFX-1 and VFX-2. The first was to utilize the TF-30 engines of the F-111, while the second would use the Advanced Technology Engine, which was being developed jointly by the USAF and Navy. Both designs included the AWG-9 weapons system, which had been developed by Hughes Aircraft for use in the F-111B. The AWG-9/Phoenix Missile System was to prove the most beneficial aspect of the F-111B program. The Navy had helped Congress to make up its mind on the F-111B program by institution of their "Navy Fighter Study II", which compared the VFX with the F-111B. The results of that study erased any doubts about the workability of commonality.

In July, 1968, the Navy tendered Request for Proposals to the American aircraft industry. Designs were received from North American Rockwell, LTV, General Dynamics, McDonnell Douglas, and Grumman, with the latter two being chosen as the best. Grumman was announced as the winner of the



Full size engineering mockup of the F-14A, as unveiled by Grumman in early 1969. [Grumman]

design competition in January 1969, and a contract for development of the VFX was signed the following month.

Grumman had taken advantage of all of the lessons learned from current state-of-the-art technology in designing the F-14. They had never seriously considered anything but the swing-wing design. (Only one of six potential designs considered for the VFX had a fixed wing.) and their experience with the F-10F and F-111B programs gave them the solid foundation to build a reliable swing-wing airplane. They used a larger percentage of Titanium than had ever been used in an airplane of this type before. (24% versus only 9% in the F-4) They pioneered the electron-beam welding process which allowed the use of such liberal amounts of Titanium, a metal that is much stronger and lighter than steel. And they had the, by now, well developed AWG-9 weapons system, and the space-age solid state computer to build around. Finally, they were building a pure air-combat weapons system, whose integrity need not be compromised with the addition of a mud-moving mission. The first Tomcat made its maiden flight on 21 December, 1970. It crashed on its second flight, on 30 December, but the cause of the crash was known and corrected before the second F-14 flew on 24 May, 1971. This was followed the same year by first flights of the number 9, 4, 5, & 6 airplanes, and the commencement of NPE I.



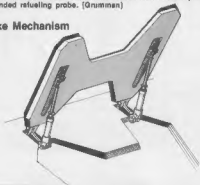
Mockup demonstrated Grumman's contention that much of on-board maintenance could be accomplished without removal of components, through design and placement of access panels. Forward avionics bay and General Electric M-61 20mm cannon are exposed in this photo. [Grumman]

80% of on-aircraft engine accessory corrective maintenance can be accomplished with engine compartment clamshell door open. [Grumman]



Easy access to AWG-9 radar is demonstrated in shot of fold-up radome. Also note extended refueling probe. [Grumman]

Airbrake Mechanism





Accompanied by A-6 chase plane, F-14 number 2 returns to Calverton after its first flight, on May 24, 1971. It was designated as the low-speed, high lift and stall/spin test aircraft. Wings were locked in 20 degree sweep position, and variable engine air inlet was locked full open for these tests. [Grunman]

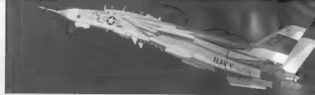
Tomcat Testing

LCDR Emory Brown has over 4,000 hours of fighter flight time, with 750 hours in the F-14, including a cruise with VF-142 aboard USS America. His experience includes combat tours flying the F-4, with VF-11 and VF-102. He is a graduate of U.S. Navy Test Pilot School, and he served with the Carrier Suitability Branch of Flight Test at NATC Patuxent River, where he was F-14 OPEVAL Project Manager. He was the fourth Navy pilot to fly the F-14, and conducted the initial carrier trials in the F-14 test program. He is scheduled to command VF-41 "Black Aces". These are his impressions of the Tomcat:

"One of the primary lessons taught at Test Pilot School was avoidance of emotional involvement in a test project. We learned that lesson well, and I assure you that the precept was retained for at least two days following assignment of the F-14 carrier suitability project. The sudden responsibility of ensuring accurate and complete testing, objective analysis, and acceptance or rejection of design features of the next generation Navy fighter fell on the shoulders of a few test pilots and project engineers. Emotional involvement?...You bet!! We lived F-14 for three years of program monitor and flight testing. They were complex years, made up of frustration, extraordinary satisfaction, highs, lows, politics, professional accomplishment, physical and emotional fatigue, and the best flying this side of combat.

The product does not have all of the flying qualities for all of the capabilities that we as test-pilots-soon-to-be-retained-to-fleet-operational-flying would have desired. But, it is unquestionably a superior weapons system and a mean flying machine. I feel a tremendous sense of accomplishment and pleasure in recalling my professional association with the development of the Tomcat.

I joined the F-14 Evaluation Team immediately upon graduation from TPS, while the program was still in a monitor status, and remained with it until the beginning of BIS trials. (Board of Inspection and Survey, which is the last step in Navy evaluation of a new aircraft before it is accepted into



Aircraft number three was devoted to structural buildup and demonstration. It was to test G-loadings for 6.5 for air-to-air, and 7.5 for ground attack missions. First flight was December 28, 1971. [Grunman]

George W. White, Jr. (left) and Emory Brown aboard USS Forrestal [CVA-59] during carrier trials of the F-14. In June 1972, White was first Naval Aviator to fly the Tomcat, Brown the fourth, and the first to fly it off of and on to a carrier. [US Navy]





Aircraft number 2 as it appeared late in test program, loaded with six Phoenix, two Sidewinder missiles, and aux fuel tanks. Spin-stabilizing drogue chute housing is visible on beaver-tail between engines. [Fitted for the test program only.] [Grumman]

NPE team poses with aircraft number 15, first of a block of four airplanes assigned for pilot training. [Grumman]



the fleet.) CDR George White was the team leader and the flying qualities and performance specialist. The team that I will be referring to consisted of six pilots, two each from carrier suit and flying qualities and performance, (Flight Test) and two from the fighter branch of Service Test, whose specialty was engines.

My partner was LCDR (now CDR) Gene Tucker, a superb fighter pilot and a totally dedicated and professional test pilot. Gene and I had been in combat in sister squadrons, where we developed a strong friendship and mutual respect. During the initial evaluation of the airplane we found that our previous association and sense of loyalty was the key element in a fight that essentially pitted Carrier Suit against the Fleet, Grumman, The Naval Air Systems Command, and other members of the evaluation team. Sounds like heavy odds, doesn't it! The object that generated this massive hassle was DLC (Direct Lift Control), a concept that had been partially tested in an F-8, but first incorporated in the F-14 as a production feature. More about DLC later.

The first Navy Preliminary Evaluation (NPE 1) followed a year of monitor during which we practically commuted between Patuxent River and the Grumman plant on Long Island. During this period, The NPE team and Bill Miller (F-14 Project pilot for Grumman, and probably the most significant contributor to the excellence of the airplane), became deeply involved in training on airplane systems and analysis of contractor test flight results. We began to sense areas that required a closer look, and to develop our flight test plans accordingly. We also became acquainted with a totally new concept in data acquisition, which was to revolutionize flight testing. The ATS (Automated Telemetry System) was designed to monitor airplane system and engine parameters and flight data in real time, which enabled the pilot to concentrate with precision on his particular test, while the ATS specialist monitored operating limits. An immediate readout permitted immediate repetition of the test if required, and validated results of a good

test. It's almost impossible to stress too much the importance of ATS to the F-14 program.

NPE 1 provided us with our first opportunity to fly the airplane. The psychological and emotional factors that a test pilot experiences on first flight and the personal pressures that follow cover a wide spectrum. The sheer excitement of strapping on the most advanced tactical fighter aircraft in the world, flying it from first roll to liftoff in 1200 feet, rotating immediately to 70 degrees nose up, then looking over your shoulder as you pass through 15,000 feet and seeing that you are still within the airport boundaries....well, that's exhilarating! But the return to reality and objective analysis must be immediate, as the test plan permits only eight carrier suitability flights during NPE 1. I had to stifle the urge to leave her in zone five afterburner and recite "High Flight" over and over and over again. At that moment, there is no man in the world who I would trade jobs with.

My immediate reaction, from a technical standpoint, was that of a tight, responsive control system, tremendous power, and an exceptionally honest airplane. The high Alpha (angle of attack) characteristics were most impressive, and the controllability afforded by the two large vertical tails and rudders was remarkable. The F-14 is a true rudder airplane that will perform unbelievable best moves in the hands of a fighter pilot. The human engineering that Grumman designed into both cockpits is a work of art, with all controls lying within easy reach. I was so totally impressed with the machine in my hands that I became concerned about my ability to remain objective. But that quickly passed as the test plan prosecution began. The hot mike interchange with ATS, during which every comment was taped with the data, tends to tone down ICS commentary and remind the pilot of his primary mission.

I was to devote a majority of my flight time during NPE 1 to the power approach (landing) configuration, and on one flight actually conducted 92 field carrier landing practice approaches. We air-refueled twice during that test flight, a practice which had a similar revolutionary effect on flight testing as that of ATS. That particular flight was a 5.7 hour endurance test...an unbelievably long time for a fighter pilot with a 2.1 hour tail. We looked at every imaginable combination of flap, wing sweep, speed brake, auto-throttle, and DLC configurations with capability to correct to glideslope from all potential error situations that a carrier pilot might experience. We flew from high, fast starts, and low, slow starts to settles at the ramp, and climbs at the ramp, and evaluated airplane response to corrections. We found some interesting results, particularly considering that the airplane was advertised to be better at the back end of the boat than anything in the inventory.

Let's talk about DLC now, and I'll discuss the carrier boarding characteristics in light of that subject.

Direct Lift Control is a landing aid, provided by the four individual spoilers on the top of each wing. When DLC is engaged, by pushing a button on the stick, the spoilers pop up to a neutral position. They can be commanded full up (+15 degrees) or full down (-4.5 degrees) with a thumb wheel on the side of the stick. When we became more familiar with it, we discovered that we could make very precise adjustments with DLC, without changing the attitude of the airplane. There is a stabilator input that compensates, of course, since DLC changes your center of pressure, which in turn changes the pitch attitude of the airplane. We use DLC in conjunction



Tomcat approaches field-arrestment gear at Pax River during "Shake, Rattle, and Roll" tests. [US Navy]



Emory Brown and Gene Tucker preflight F-14 at Pax River. Tucker would later earn notoriety by bagging a Mig-21 at night over North Vietnam, while flying a Phantom with VF-103.

Main Landing Gear





Tomcat on the Independence, during non-flying deck trials to demonstrate its carrier compatibility for congressional skeptics. It is shown taxiing off elevator and into hangar deck, and taxiing on deck under watchful eyes of deck crew, who were ever-ready with chocks in hand. [US Navy]



with auto-throttle, and the combination is really very nice for flying aboard.

Throughout the test program, Grumman was under the Congressional gun, and under public scrutiny for potential cost overruns and all the other buzz words that apply to the typical defense contractor today. (Authors note:) It should be remembered that Grumman was laboring under a fixed-cost contract that, because of inflation, would eventually bring the company to the brink of bankruptcy. Government negotiators, also feeling the pressure of the above noted buzz words, were unwilling to relent on the contract.) They were in a tight position, and anticipated even tighter days coming, while trying to function within the letter of the detail specifications for the F-14, in order to avoid costly penalties. One primary requirement called for a maximum carrier landing speed of 128 knots. This is a tight restriction for an airplane capable of speeds in excess of mach 2.4, but Grumman's swing-wing design managed to accomplish it...except with DLC engaged. DLC adds 6 knots to the approach speed and, at max arrested landing weight, generated a 132 knot approach speed. There were 2 options as far as Grumman was concerned...increase the optimum angle of attack for approach by 2 units, thereby slowing the airplane to 128 knots...Or delete DLC.

While furiously lobbying with NAVAIR and The Fleet, and attempting to convince us to accept option two, Grumman installed a complex dual action angle of attack bug that varied optimum approach selection from 15 units in conventional configuration, to 17 units with DLC engaged. The auto-throttle computer responded accordingly. Not a bad idea, you might say. Well, Gene Tucker and I disagreed entirely with the concept and with both of Grumman's options. The airplane flies much better at 15 units AOA, and must have DLC engaged to generate decent engine response and provide the improved flying qualities that accompany a slightly higher airspeed. Those of us who have landed aboard an aircraft carrier on a black, rainy, turbulent night with a very low ceiling, and no divert field in the vicinity, will tell you that the epic "High Flight" does not apply at that instant. What does apply is rapid and effective response from flight controls and engines and a stable flying machine, in deference to those select few of the world's

aviators who would fly the F-14 in those conditions, we insisted on the third option...Retain DLC, consider it mandatory for night and preferable for day operation, give Grumman relief on the specification requirement for 128 knots, and set the optimum approach AOA at 15 units. Sounds logical, and should be simple, right? Well, it wasn't so simple, because Grumman did not believe that they could escape the cost penalty. Thus began "The Great DLC Fight of the Century".

First let's set the record straight on the F-14 in the carrier landing environment. The rigidity of design spec for both high and low speed performance requirement generated some features in the landing configuration that increase pilot workload. With training, the basic airplane (without DLC) can be flown aboard nicely, but honors for the Golden Tailhook (awarded to the squadron whose carrier landing performance is the best within the airwing) are more difficult to achieve than with the F-4. The basic airplane is perfectly safe, it just isn't beautifully smooth on the glide-slope. It has high pitch inertia similar to the RA-5C; float characteristics like the A-6A; residual thrust from the fan engines that keep the throttles in the lower, less responsive zones; a gust responsive wing; side force characteristics that decrease seat of the pants sensitivity to sideslip; a lateral control system (spoilers) that staircase it with lineup corrections and diminish precise heading control; and an auto-throttle that requires considerable anticipation. These observations are all relative, and I base my analysis on a comparison with all other contemporary fleet aircraft. (Authors note: LCDR Brown is carrier qualified in all tactical Navy aircraft, and has flown all contemporary Navy aircraft. He has taken individual Golden Tailhook honors in two air wings, and is highly respected within the Naval Aviation community.)

Now I am going to hedge a bit and qualify my statements for those skeptics who will read this analysis and interpret it incorrectly. We have addressed the basic airplane flying qualities without DLC engaged. To a test pilot whose responsibility is to dissect and evaluate the airplane, the features discussed are all significant, but the fleet can live with them and perform in a safe environment. Pilot workload is increased by each, but the human being is adaptable and with training and experience will learn to accept them and to

Emory Brown and Phil Anselmo discuss preflight with Grumman plane captain prior to test flight at Calverton. [Grumman]



[Below Right] Number 2 with flaps, slats, landing gear, and speed brakes out. Note large stiffeners on fuselage, inboard of wings. Size of these was cut down on production aircraft. [Grumman]

Another view of the number 2 airplane, showing position of six Phoenix missiles. Wings are in full 68 degree sweep position. [Grumman]



maximize his performance accordingly. The single most significant factor in facilitating pilot adaptation is DLC. The extension of spoilers slightly into the airstream increases drag, which improves flying qualities laterally and longitudinally and thereby reduces the glideslope and lineup problems. Auto-throttle capability is improved with all these factors...and the attorney for the defense rests his case!

There are still scare all over my body from the DLC Caper, but it is in production airplanes and it **does accomplish** design tasks. Without DLC we would have some real problems flying the F-14 aboard the boat.

After the NPE, we had to take the airplane down to Norfolk and hoist her aboard the USS Independence for deck trials. This was fairly significant, because with Congress looking at the airplane for a possible buy or no buy decision, the most important thing is for a carrier airplane to be seen on the deck of a carrier. So we drove it around the deck, up and down the elevators...everything short of flying her, and gave the ship operators an opportunity to become familiar with the F-14. Then we flew her back to Pax River for further contractor demonstrations. They were conducting the carrier arrested landing testing...what we called the "shake", which is short for shake, rattle, and roll. We put the airplane through an awful lot of throes, taking her up to the limits of her design capability, twenty five foot per second landings which the contractor is supposed to demonstrate. During one of these landings, Charlie Brown, the Grumman test pilot, hurt his back very severely. (The airplane came through unscathed.) In flying these tests, I would take the airplane out, for instance, and start with a three degree glide slope, build to 4, 4 1/2, 5 etc., etc., until we got a high sink landing, which was the datum point we were looking for. Then we would take it and fly to what we call a roll and yaw opposite, or a roll and yaw same. If it's a roll and yaw opposite, it's a steady heading sideslip, in which I have 5 degrees right wing down, and five degrees left sideslip, which I hold all the way until





Plugged into the basket and taking on fuel. Instrumented boom on nose recorded yaw, pitch, and roll data during all phases of flight testing (Grumman)



Number 2 F-14 is refueled by the number four A-6, which is still maintained and flown by Grumman from its Calverton, N.Y. flight test facility. Use of several in-flight refuelings on each flight allowed maximum amount of data to be collected in minimum time during NPE-1 (Grumman)

[Left] Refueling from C-130. Excellent low-speed handling qualities of the Tomcat make it a "piece of cake" to refuel from complete range of tankers in Navy inventory. Standard technique of flying formation on the tanker while NFO "talks you into the basket" is used with the F-14 (Grumman)

touchdown. What we achieve from this is substantial side forces on the second wheel to touch down through the moment arm and I also has a substantial twist on the airframe. A roll and yaw same entails flying the glide path and just before touchdown applying lateral and directional control inputs. A missed wire, bolter is really interesting because the side of the runway is then a thing in the ground roll path. That usually required a quick and definite response to pitch without grass in the main mounts. Then we would fly a 1 to 2 degree glide slope which is very flat to a free flight engagement. As we approach the runway we start to increase the angle of attack until we feel the hook dragging on the deck. When I catches the wire, it really slams me back down. Then we fly to an off-center arrested landing in which we land 20 feet left or 20 feet right of the centerline on a very short runout arresting wire which is a hell of a rough landing. That's a shake and that's the kind of a test we put the F-14 through. The concept was to subject the airplane to the most radical landing that might be encountered aboard ship. At the end of these demonstrations we had about another four months of testing to do before we could actually take the airplane aboard ship.

About that time, the word came down from CNO that there was a lot of talk in Congress about the airplane not being carrier suitable and there was some talk about scrapping the whole project. All of this talk stemmed from

some of the official technical language that we used in our reports that were asked to people like Jack Anderson, who then printed it out of context, or because of their ignorance of the way new aircraft testing is done, drew incorrect conclusions from the wording. For example, we had several categories of deficiencies that we used in grading various aspects of the airplane. A "preclude" deficiency would "Preclude mission accomplishment", a "limit" deficiency would "Limit mission accomplishment", and an "avoid" deficiency would be "avoid in future design", which meant that we could live with it on the airplane, but don't incorporate that feature in the next airplane you design. And of course topping them all in significance was the safety of flight deficiency. Well, when Congress sighted one of these reports, they see that wording and immediately conclude that the airplane's design deficient. The upshot of the whole thing was that Congressional pressure forced us to take the airplane aboard ship four months early to prove that the F-14 could do what it was designed to do: that is, operate on and off a carrier.

We were forced to give it our best shot right up until the last minute getting the airplane ready for carrier operations. Then we made thirteen touch and go landings and two arrested landings on the Forrestal and that was our first experience with the machine. These operations were not without problems. The F-14 has a boosted throttle, which requires about seven pounds of force to actuate. When that fails, it reverts to manual mode, which normally requires fourteen pounds of pressure, and that is very a girl can't. I had to fly the airplane aboard ship that way. We also had a wing sweep problem. The flap jiggling was giving us problems, and the wing would at stick at 50 degrees, had to overcome that problem while airborne, so that I could bring the airplane aboard ship. During all of this there was an F-4 waiting on deck, ready to launch with the films of our tests. As soon as we finished, the film was loaded on the F-4, and flown to Andrews AFB, where the film was off loaded, rushed to Anacostia for processing, and hand carried to CONG, who took it to Congress, just to prove to the people on the hill we had successfully operated the F-14 off and on a carrier. It was a shame that we were put through all of that. They knew the airplane was good, and the pressure on us was terrific. During that period, I believe I was from the 8th of March until the end of August, we worked from 6 a.m. until 10 p.m. every day without a day off. Saturday, Sunday, 4th of July or anything! That encompassed deck trials, then to carrier preparation, then to carrier trials. Shortly after we returned from carrier trials, B.I. Miller was killed while practicing for an airshow. He was to have done a max performance takeoff, climbing to 2,000 feet, rolling over, and while turning within the field boundaries, sweep the wings from 30 degrees forward to full aft. During a practice run he encountered the same problem with the wing that had with the wing at stick at 50 degrees. We all knew about the problem, and knew that it could be corrected by "tricking" a flap interlock microswitch that wasn't being met. This was one of those days when there is a fairly low ceiling, which sort of obscures the horizon. B.I. had flown out over the bay and apparently while he was looking down in the cockpit, trying to trick this switch, he flew into the water. The cost of this crash to the program was immeasurable, mostly because of the loss of B.I. Miller, but also because the airplane was highly instrumented for our tests. I was the only airplane we had instrumented for carrier suit at the time. The

situation was sensitive, and we had to recover the airplane to prove what had happened, though there was absolutely no doubt in my mind what we would find.

As we concluded the accident investigation, we progressed immediately into NPE 2 for a look at the discrepancy corrections from NPE 1, and a significantly expanded flight envelope. I really had the opportunity to look at the F-14 as a fighter in the typical ACM environment during this evaluation, as we were able to complete the carrier suitability tests and delve into the flying qualities and performance side of the house. My technical analysis, "OUT OF SIGHT!" My objective analysis, "FAR OUT!!!" I hailed that airplane through a series of overheads, high-G turns, and a low speed maneuvers that would have departed and spit out anything else in the air and flew her straight up until she hit zero and backed down and then did it all over again. I had achieved total confidence in this machine with a minimal amount of experience and felt like I had put her on the right flighting jumpseat, rather than stepped in and sat down. Do I sound like a Tomcat Advocate? Well, I have had ample justification and opportunity to become one. There is no airplane better for the multiple mission. In fact, there are none that even come close! I want to elaborate on that, but I feel I am covering one more subject that I consider to be very important.

We didn't anticipate an active spin problem and the Grumman approach

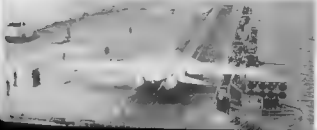
Emory Brown discussing a point during NPE. Fatigue is evident on faces of all pilots, as they worked a five month stretch of 18 hour days, without a single day off. In order to head off critics of the F-14 who kept constant pressure on for cancellation of the program, in spite of all the flak thrown at it, and the killing pace maintained throughout the test program, the Tomcat proved itself one of the safest airplanes ever to enter the fleet. (Grumman)





The number fourteen airplane being hoisted aboard carrier. It was used for maintenance and reliability work in the test program. [US Navy]

Number ten airplane was used for initial carrier qualifications of the Tomcat. It is seen on number one cat of USS Forrestal during June, 1972 tests. Tremendous heat generated by F-14's twin TF-30 engines requires use of new, water cooled, Mark 7 blast deflectors on carriers operating the F-14. Forrestal had just had the new deflectors installed at time of these tests. [US Navy]



to analysis was that of spin prevention, rather than spin recovery investigation. Chuck Sewell, Chief Test Pilot for Grumman, had the number two airplane specially instrumented and equipped for his spin program. The airplane had a large spin chute, a hydrozine APU for engine restart, and canards fitted alongside the nose. Chuck is a wizard in the flight test game, and was honored for his accomplishments in the F-14 program. We lost the advanced analysis of the spin testing when a hydrozine leak atomized and caught fire during flight. Chuck brought her home, but the bird received strike damage and was not to fly again. As a result of his tests, however, a spin prevention device was developed for the airplane that took conventional lateral control surfaces out of pitch control and shifted roll to rudders in response to stick input at high alpha. An interesting approach that we are still evaluating.

We have lost three airplanes to spins, but two were in the test environment and resulted from unusual circumstances that occurred at the outer edge of the envelope. The third is still under investigation. NASA testing indicated that the F-14 would spin only in the flat mode and would be irrecoverable once established, but also that a significant effort and failure to apply proper departure recovery techniques would be required to spin the bird. We in the fleet consider the spins to date to be so rare and do not consider loss of control and spin to be an operational problem.

The F-14 began life as a tremendous concept. Grumman had done their homework during their participation in the F-111 program. So when the time came for the F-14 competitive bids, they were ready. We were pushing the state of the art in a lot of areas: the fan engines for a fighter with afterburner, the variable geometry wing, the newest concepts in controls and displays, and a subject on which I have not commented: the unparalleled AWG-9 weapons system and Phoenix Missile. The most controversial of these had been the engines. It turns out that we really need the advanced technology engines, both from the higher thrust and better fuel specific features. We really had some initial problems with our TF-30-P412 engines, but they have been corrected and our confidence eval restored. Just as the failure to incorporate new engines as scheduled resulted from a failure of those in power on the H1 to recognize our requirements, most other problems with the airplane were a result of the push for fleet introduction and a shortfall of funding. We still operate on a shoestring with insufficient parts to repair our machines. But that's another story, to be told another day.

When everything is said and done, I am extremely excited about the F-14. The weapons system that we have in it is superb. We can do things with the F-14 in a forced defense environment that you couldn't do with a dozen F-4s. I feel when I'm up there that I have the entire picture. The radar capability is just fantastic, and the weapons that we carry allow us to engage from 80 miles out, right down to within gun range. The thought that went into designing the airplane, not just as an interceptor, but as a total fighter, was really just fantastic. The ultimate catalyst that makes this airplane superior to the air superiority fighters currently in vogue is the two man concept. The NFO is the most valuable asset that Navy tactical aviation has today. In the intercept role, he is a dedicated weapon system operator. In the ACM role, he is another set of eyes, another skilled tactician, and a superb protective device. I am completely sold on the Tomcat, and I am looking forward to a long and rewarding relationship with the bird.



Tomcat being positioned on the number one catapult of the USS Enterprise. CVA-N-65 Jet blast deflector is 36 feet wide, 14 feet high, and folds flush into carrier deck. [US Navy]

Tomcat number 41 [158980] performing touch-and-goes on the Forrestal, November 1973. It was performing Carrier Suitability Tests, as the test program continued. Per copy cost of the F-14 at this time was \$14.7 million, including R&D, support equipment, and spares. [US Navy]



Nose gear has cleared the catapult shuttle as F-14 begins to rotate from the deck of USS Forrestal. [US Navy]

Number 15 airplane launches from the waist cat of the Enterprise in March, 1974. This launch was accomplished using military power only (no afterburner). [US Navy]



8980

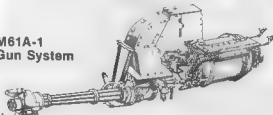


Tomcat crew completes preflight checks, as RA-5C approaches Forrestal for landing, December, 1973. [US Navy]

Bomb Rack



M61A-1 Gun System



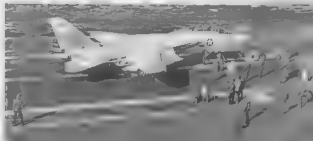
Approaching Forrestal for touch and go landing. [Note tailhook is not extended but speed brake is.] In early 1973, the Navy proposed acquisition of a total of 722 F-14s, including 190 for USMC. [US Navy]



Tomcat hits hard during Carrier Suitability testing touch and go landing aboard Forrestal. Note that flaps and leading edge slats are retracted. Aircraft stability and handling for coming aboard was tested in several configurations. [US Navy]

Coming aboard the Enterprise during familiarization for the first fleet squadrons. Former Phantom drivers found they could no longer count on being number one in the air group, as the straight-wing F-14 was tougher with which to get an "O.K. Pass". [US Navy]

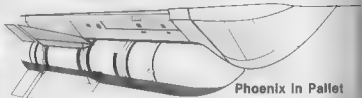
Number 14 Tomcat blew a tire while coming aboard Forrestal during December, 1973 Carrier Suit testing stopping it dead in its tracks with tailhook still engaged to arresting gear. [US Navy]



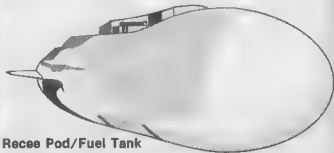


Hangar deck of Forrestal, with two Tomcats aboard for Carrier Suit tests. F-14 in foreground has wings at 75 degree over-sweep position, a feature that enhances handling in confined spaces aboard carriers [US Navy]

General Daniel "Chappie" James, current Commander of NORAD, after a 1974 orientation flight in the Tomcat with Capt Lewis "Scotty" Lamoreaux, Fighter Air Early Warning Wing Pacific. It has been suggested that the F-14, as the best interceptor ever built, would make a logical replacement for ADC's ageing F-100 fleet, though intra-service politics make it's choice highly unlikely [US Navy]



Phoenix In Pallet



Recce Pod/Fuel Tank

Tomcat with Chuck Sewell, Grumman's chief test pilot for the F-14, at the controls, and Commander George White in the back seat, at the six of a Phantom flown by Lt. D. Walker of NATC during series of dogfights described on this page. [Grumman]

Tomcat vs. Phantom

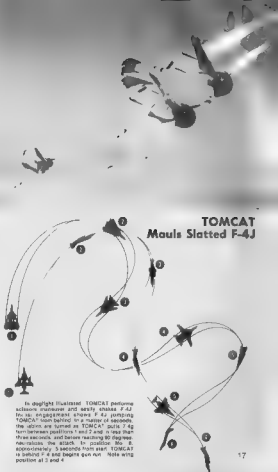
While the Tomcat was being designed and built, engineers at McDonnell Douglas were striving to find ways to prolong the life of the Phantom. What they came up with was the slatted wing, which dramatically improves the F-4's air combat maneuvering abilities. In fact, the improvement was so dramatic that some calculations were made to the effect that the slatted Phantom might be able to compete with the Tomcat in the ACM environment. In order to test these theories, the Navy arranged a head-to-head confrontation between the two aircraft. The dogfights took place at Calverton, with Chuck Sewell flying the Tomcat, and Lt. D. Walker, Navy Test Pilot, flying the Phantom.

The initial engagement took place at 35,000 feet at 1.25 Mach, with the Tomcat in the lead. Remaining tests ranged down to 18,000 feet at 0.5 Mach.

The Tomcat's performance was superior in all areas. It pulled in excess of 7 Gs in initial breaks, flew at 48 degrees angle of attack, and retained excellent stability and control at speeds as low as 180 knots, while simulating kills on the F-4.

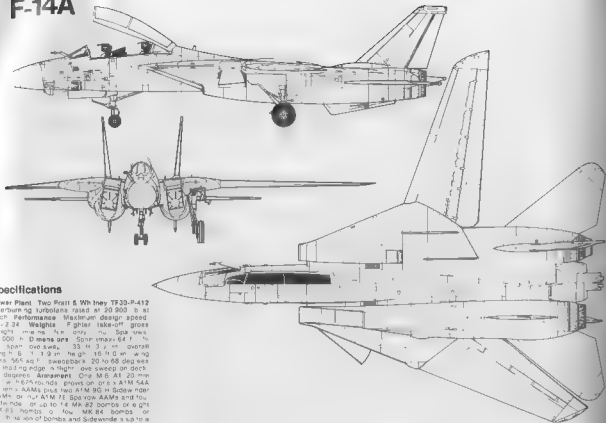
Throughout the test, the Tomcat commanded each engagement, displaying the qualities vital to an air-superiority fighter, maneuverability, turning performance, and specific energy (a measure of excess thrust used to produce superior turn, acceleration, and climb performance). While in lead position, the Tomcat was out of gun range a most instant and out of missile launch zone in several seconds, and in a few seconds more, on the tail of the F-4 tracking it.

The major systems which allowed the F-14 to so completely dominate the F-4 were its afterburning turbofan engines, and its swing wing. The wings are automatically positioned by the Mach Sweep Programmer, which provides fully automatic wing sweep as a function of Mach number and altitude. The F-14 also has maneuvering flaps, the outboard two sections of the landing flaps, which can be extended 10 degrees when the wings are forward of the 50 degree sweep position. The maneuvering flaps are actuated by a thumb-wheel on the stick to increase lift and a low more G to be applied to the airplane, thus enabling it to make tighter turns. Latest models of the F-14 also have leading edge maneuvering slats, which are automatically deployed and retracted at pre-programmed angles of attack.



In dogfights illustrated, TOMCAT performs maneuvers maneuver and early shakes F-4J. In this engagement, shows F-4J jumping TOMCAT's turn behind in a matter of seconds, the victim, are turned as TOMCAT pulls 7.4g turn between positions 1 and 2 and in less than three seconds, and before reaching 80 degrees, neutralizes the attack in position No. 3, approximately 5 seconds from start. TOMCAT is behind F-4 and begins gun run. Note wing position at 2 and 4.

F-14A



Specifications

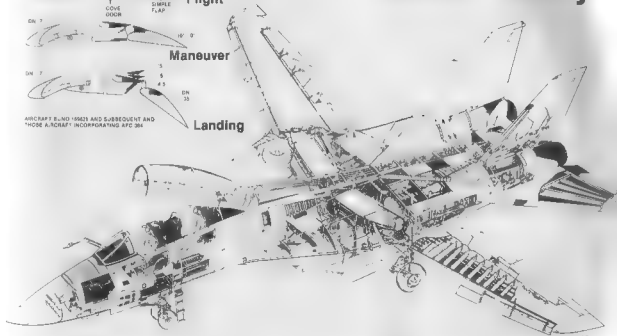
Power Plant: Two Pratt & Whitney TF30-P-412 afterburning turbofans rated at 20,900 lb at each. **Performance:** Maximum design speed M-2.34. **Weights:** Fighter take-off gross weight means for only two Sparrows. 55,000 lb. **Dimensions:** Span max: 64 ft. 0 in. Span over sweep: 33 ft. 3 in. Overall length: 61 ft. 9 in. Height: 16 ft. 0 in. Wing area: 565 sq ft. Sweepback: 20 to 68 degrees. Leading edge sweep: 0 to 68 degrees. **Armament:** One M6 A1 20 mm gun. 675 rounds. Provisions for 6 x AIM-54A Phoenix AAMs plus two AIM-9C Sidewinder AAMs or four AIM-7E Sparrow AAMs and four missiles or up to 14 Mk 82 bombs or eight Mk 83 bombs or four Mk 84 bombs or combination of bombs and Sidewinders up to a external load of 14,500 lb.

Wing Control Surfaces

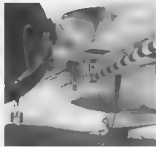
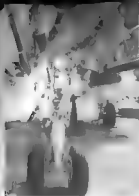


AIRCRAFT BUILD 15623 AND SUBSEQUENT AND
 THOSE AIRCRAFT INCORPORATING AFC 384

Tomcat Cutaway



Tomcat Walkaround



Cranked pylon, with Sidewinder launch rail (top), and Sparrow launch rail (bottom). [Tom Hayden,

Main gear and wheel well, from front. [Author]



[Above Far Left] Nose gear, from front. [Tom Hayden]

[Above Center Left] Phoenix launch pallet, from rear. [US Navy]

[Above Center Right] Tail hook, with safety pin installed. [Tom Hayden,

[Above] Port Intake. [Author]



Nose
Landing
Gear



The number 6 airplane was assigned to Pax River for aerodynamic performance and demonstration work of a production configuration aircraft [Jim Sullivan]

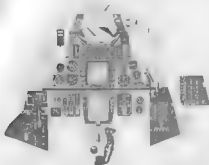
[Right] Boarding ladder, extended [Author]

[Far Right] Main Gear [Hans Redemann,

Refueling a pre-production Tomcat aboard Forrestal, during Carrier Suit testing in June, 1972 [US Navy]



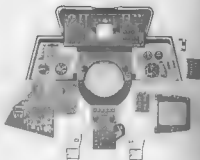
Pilot's Instrument Panels



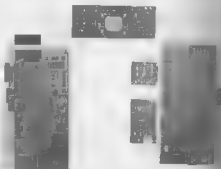
Player Instrument Panel and Console

[illegible]

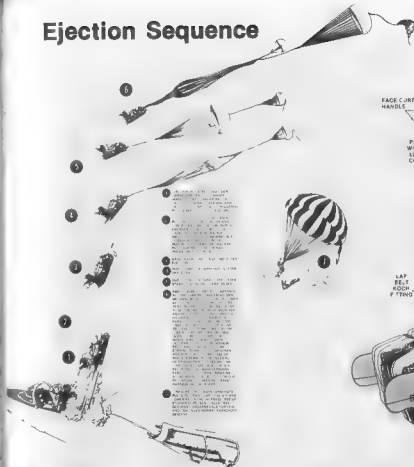
NFO's Instrument Panels



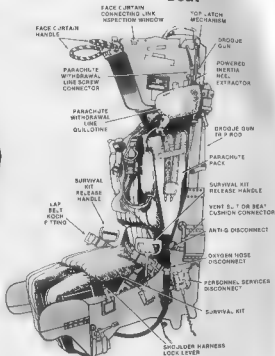
APD Measurement Panel and Console

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Ejection Sequence

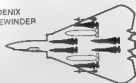


MK-GRU7A Ejection Seat



Weapons Loading

6 PHOENIX
2 SIDEWINDER
GUN



6 SPARROW
2 SIDEWINDER
GUN



4 PHOENIX
2 SPARROW
2 SIDEWINDER
GUN



2 PHOENIX
1 SPARROW
4 SIDEWINDER
GUN



4 PHOENIX
4 SIDEWINDER
GUN



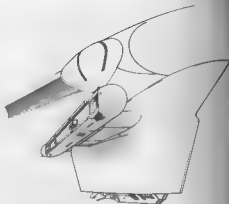
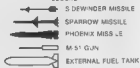
4 SPARROW
4 SIDEWINDER
GUN



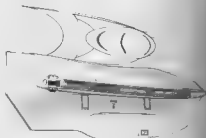
2 PHOENIX
3 SPARROW
2 SIDEWINDER
GUN



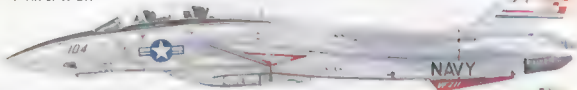
LEGEND



**“Cranked” Pylon for
Sidewinder and
Sparrow Missiles**



F-14A of VF-211



F-14A of VF-32



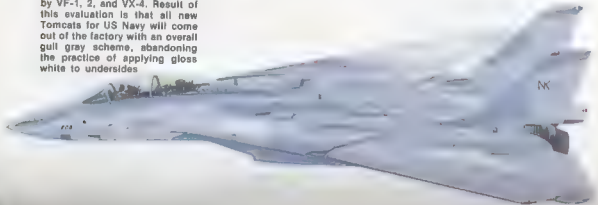
F-14A of VF-1



F-14A of VF-14, with Bicentennial markings.



F-14A of VF-2 in special three-tone gray splinter camouflage, which has been evaluated by VF-1, 2, and VX-4. Result of this evaluation is that all new Tomcats for US Navy will come out of the factory with an overall gull gray scheme, abandoning the practice of applying gloss white to undersides





First two F-14s of VF 41 over Chesapeake Bay April 1977. Author

(Above Right) Experiments, after a pattern camouflage was applied to some Tomcats at NAS Miramar for evaluation in ACM situations. Latest Tomcats to be delivered to the fleet will carry an overall light gull grey scheme, and official directives discourage the application of squadron markings that require large blocks of man-hours to apply and maintain. Don Logan

(Below Right) F-14A for the Imperial Japanese Air Force. In IAF camouflage, with pre-delivery U.S. national insignia. Pilot tube on nose indicates that this is one of the latest (block 95) Tomcats, with automatic leading edge maneuvering slats. Hans Redemann

F-14A of VF-114 "Aardvarks", NAS Miramar, January 1977. Scott Brown





Two views of the F-14 flown by Cdr Jim Taylor and Lt Kurt Strauss at the 1973 Paris Air Show. Note I/R Seeker and ALQ-100 antenna under nose and the pre-production M-81 gun fairing. [Production models have a more forward elongated gun fairing.] [Hans Redemann]



Into the Fleet

The Tomcat's official introduction to the fleet occurred on October 14, 1972 with the commissioning of the first two F-14 Squadrons, VF-1 and VF-2. Actually, neither one of these squadrons was "new" in the strictest sense of the word. In fact, they are among the oldest in the Navy.

VF-1 was originally established on July 1, 1922, and operated as such until its redesignation to VF-2 in 1934. A year later the second VF-1 was established and served for two years, when it was redesignated VF-6. The third VF-1 was commissioned May 1, 1943, and served throughout the balance of World War II, completing a 20 to 1 kill ratio against the Japanese. It was deactivated in October, 1945. The current VF-1 is the fourth to carry the designation, but the first "Two Pack."

VF-2 was established at the same time as the original VF-1, and served until 1927. It was the first squadron to operate from the Navy's first carrier, the USS Langley.

The supplying of pilots constituted a heavy drain on the Officer Personnel of the Navy during the early days of Naval Aviation, and Congress decided that 30% of Naval Aviators should be enlisted men. The Navy promptly decided to form an all-enlisted fighter squadron, and VF-2 was reformed as such in January, 1927, with the original VF-2 being redesignated VF-8.

VF-2 enjoyed a varied number of assignments in the between-the-wars period. Flying from NAS San Diego, various battleships, USS Langley, USS Saratoga, and USS Lexington.

When WW II broke out, most of VF-2's enlisted pilots were reassigned as instructors. The squadron fought aboard USS Lexington until she was sunk in the battle of the Coral Sea. VF-2 was deactivated on July 1, 1942. It was reformed on June 1, 1943, and compiled an enviable record against the Japanese during the march across the Pacific in 1944. The squadron was once again reformed in late 1944 and ended the war doing aerial search for POW camps in Japan. It was deactivated in November, 1945.

While the first two F-14 Squadrons were going through training with VF-124, in preparation for their first deployment, the world was introduced to the Tomcat at the Paris Air Show, in June, 1973. The professional aviator community was well aware of the controversy and turbulent developmental history of the F-14 to that date, but they were not prepared for the show that the F-14 put on at Paris.

In eight minutes of flying a production F-14, flown by a fleet aircrew, (Cdr Jim Taylor and Lt Kurt Strauss) of VF-124, showed the world that the U.S. Aerospace Industry was still the world's leader in producing new generation fighter aircraft.

The flight demonstration began with a half Cuban Eight at takeoff, going through the top at 2,500 to 3,000 feet with 200 to 250 knots airspeed, followed by a slow roll with the wings sweeping fore and aft during the maneuver. Then came a knife-edge pass at 350 to 400 knots with a 6 G 360 degree steep turn performed within a 2,000 foot radius at 500 feet, followed by a lock under break to slow to landing speed. Gear and flaps were lowered and the Tomcat

The F-14 Weapons System...or...How to Become an Ace on the First Pass.

The AWG-9/Phoenix Missile system in the F-14 holds many world records for effectiveness. The charts below detail how the records were set. In addition to what is illustrated here, the Phoenix has demonstrated its tenacity by achieving a kill on a QF-86 drone that had pulled 8 G's in attempting to break lock and elude the missile. The Phoenix pulled 18 G's and scored! Success rate for the first 100 Phoenix missile firings was a phenomenal 84%! The reason for all the records and the sub-title above is the AWG-9 radar. It is virtually the

only new thing to come along in the way of fighter radars in years. It allows the F-14 to track 24 targets simultaneously and to fire at six of them simultaneously. The AWG-9 radar covers such a great volume of airspace compared to other systems in contemporary service that the F-14 crew has nearly an extra two minutes of intercept time when they spot a supersonic target.

Once fired, the Phoenix missile is on its own. It carries its own radar guidance system and is capable of penetrating the most sophisticated known enemy ECM jamming screens. This allows the F-14 to maneuver against other threats. When armed with the complete mix of air-to-air weapons (Phoenix, Sparrow, Sidewinder, and gun), the Tomcat is the most versatile and formidable fighter/interceptor you can come up against. No wonder Tomcat drivers have adopted as their standard challenge, "ANYTIME, BABY!"

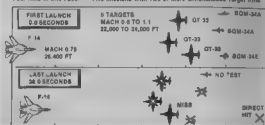
HIGH ALTITUDE, HIGH SPEED TARGET

- Mach 2.7 +, 51,000 Foot Target Kills.
- Eight Kills on Targets Flying at Mach 1.8 and 48,000 Feet.



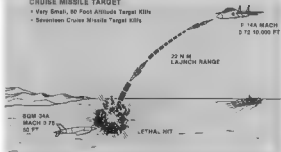
SIMULTANEOUS SIX TARGET ATTACK

- Four Kills in One Pass.
- Five Missions With Two or More Simultaneous Target Kills



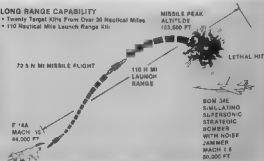
CRUISE MISSILE TARGET

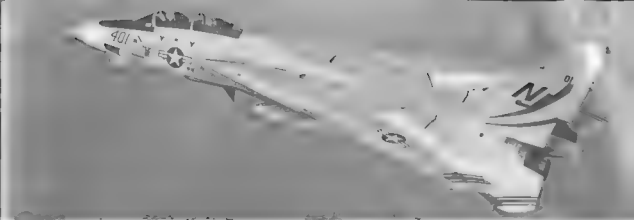
- Very Small, 80 Foot Altitude Target Kills
- Seventeen Cruise Missile Target Kills



LONG RANGE CAPABILITY

- Twenty Target Kills From Over 30 Nautical Miles
- 110 Nautical Mile Launch Range Kill





VF 124 was first squadron to operate the F-14 for the purpose of fleet squadron personnel training. Patchee at right indicate willingness of Tomcat drivers to engage in ACM, and to demonstrate the superiority of their machine to all comers. Lower patch was a special run for the Paris Air Show.

performed a "wing walking" maneuver at 105 knots down the runway, with a near vertical climb on afterburner to pattern altitude, followed by normal approach and landing.

The Paris Air Show, a world-renowned for its hairy flying, with national pride on the line. Quite often, its flying demonstrations end in disaster. The Tomcat's demonstration impressive as it was, was flown daily, and on time. The F-14's crew repeatedly stressed the fact they were not approaching the limits of the Tomcat's performance envelope, and in fact were just a fleet aircraft, flying a fleet airplane. For their performance, Cdr. Taylor and Lt. Strauss were nominated for the Harmon Trophy, which is given for outstanding aeronautical contribution in a non-combatant category. During the same show, the Russian Supersonic Transport the TU-144, broke up in mid-air, crashed and burned, while attempting maneuvers outside of its performance envelope.

The F-14 went to sea for the first time. In an operational deployment, on the USS Enterprise, September 7, 1974. Ironically, it was the eighth Grumman Cat, sailing aboard the eighth ship of her line to bear the name Enterprise. It was the first Grumman fighter to be deployed since the F-11F Tiger completed its last tour of duty in March 1961. It was perhaps symbolic that the F-14 would end this deployment by covering for the withdrawal from Vietnam in 1975, an event that was the culmination of one period in American military history, was being witnessed by a new generation of American fighter aircraft.



VF-1 flightline at NAS Miramar, late 1973. Plane captains are still in process of applying the original and distinctive "Wolfpack" markings.



Lt. Bob Vincent of VF-1, checks Sidewinder missile during preflight of his Tomcat on first deployment of the F-14 to sea, aboard USS Enterprise. [US Navy]

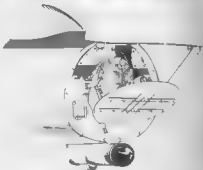
With preflight complete, Vincent and his NFO prepare to mount up [US Navy]

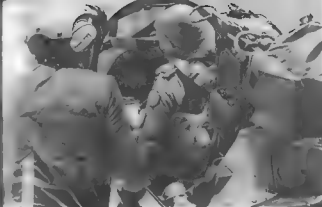


Vincent continues preflight with check of AIM-7 Sparrow missile [US Navy]



AWG-9 Radar



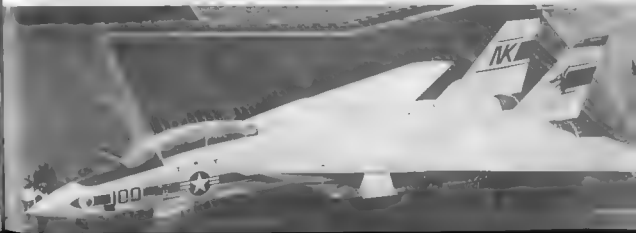


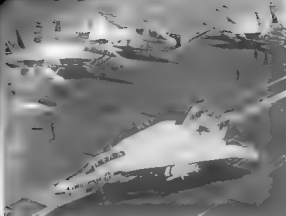
Pilot Captain will assist Vincent in fastening his torso harness to parachute fittings, leg belt, and leg restraints in aircraft. Pilots often wear padded skull caps under their hard hats to reduce fatigue on long flights. [US Navy]



PC assists NFO in strapping into rear cockpit. [US Navy]

VF-1 crew goes through preflight checks prior to launch from USS Enterprise, March, 1974. [US Navy]





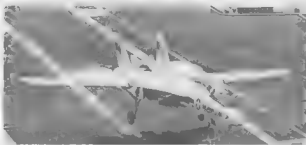
Tomcat taxis forward to cat aboard Enterprise. Wings are at 75 degree oversweep used for stowage. VF-1 and VF-2 were first squadrons to take the F-14 to sea on a regular deployment, beginning in October 1974 [US Navy]

Tomcat in landing configuration. Bob Lawson v.a. Jim Sullivan



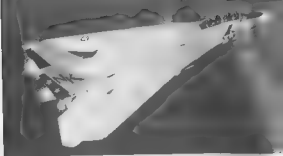
F-14 is positioned on waist cat for launch. Relatively large size of Tomcat is evident in this side-by-side comparison of Tomcat and Corsair II [US Navy]

Seconds from completion of an "O.K. Pass" F-14 about to pounce on the number three wire of Enterprise during Westpac cruise in March of 1975 [US Navy]



Tomcat with glove vanes extended. Glove vanes can be operated by the pilot by rotating the maneuver flap thumbwheel to the rear. up to 1.5 Mach. Above 1.5 MN the glove vanes are programmed full out (15 degrees) automatically by the CADC overriding any pilot command through the thumbwheel [US Navy]



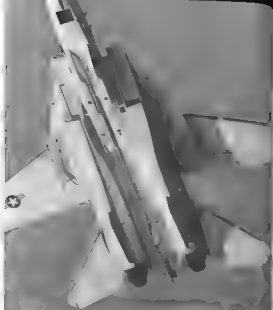


VF-2, F-14 Antennae on fuselage spine are, from front to rear: TACAN and UHF Comm, and IFF/APX-72-UHF Data Link. Data link communications allows Tomcat crew to receive relatively jam-free real time data from Carrier Combat Information Center or from E-2 Airborne Command Post. [US Navy]

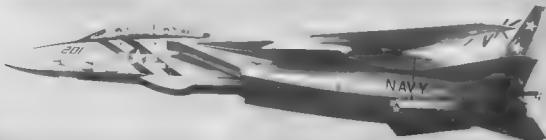
[Left] VF-2 Tomcat is hoisted aboard USS Enterprise prior to first deployment in 1974. It carries Phoenix launch pallets on forward fuselage stations. Sparrow launch points are on fuselage centerline [2], and under Phoenix pallets [2]. [US Navy]

VF-2 Tomcat performs low-altitude roll, while sweeping wings forward and aft, during 1976 Show at Iruma AB Japan. [S. Ohzaki]





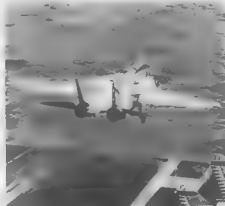
Above] VF-2 Tomcat takes off from Miramar August, 1973. (Bob Lawson via Jim Sullivan) [Right] Differential movement of stabilizers is evident as Tomcat performs roll. (S. Ohtaki) [Below] 68 degree wing sweep, high speed, low altitude pass at Iruma AB, Japan (S. Ohtaki) [Left] Postshow taxi-in at Iruma (S. Ohtaki)





With steam from prior launch lingering, Tomcat is directed to number one cat aboard Enterprise. [US Navy]

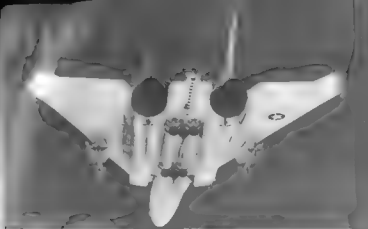
Tomcat roars off the waist cat of Enterprise during operations in support of the evacuation of Saigon in 1975. Note stabilators are fully deflected [nose up] position. [US Navy]



Tomcat demonstrates high angle of attack climbout at Truam. [B. Chisak]

Experimental camouflage applied to VF-2 Tomcat in 1976. [Don Logan]





Control Stick



[Left] VF-211 Tomcat shows off weapons load that allows maximum flexibility in air-to-air combat, including long range Phoenix, medium range Sparrow, short range Sidewinder, and, of course, real close range M-61 cannon [Grumman, [Left Below VF-24 "Red Checkertails" Tomcat at Miramar, January, 1976 [Bob Lawson via Jim Sullivan]] [Below] VF-24 CAG aircraft tail markings consist of red check, red shadowed black "00" and red, yellow, blue, orange, green, black, dark blue and brown stars [clockwise from top] [Scott Brown]





F-14A of VF-211 "Checkmates" at NAS Miramar, May, 1978. Open access door on fuselage ahead of ventral fins is engine oil refill point [Duane Kaszika via Jim Sullivan]

Flight of VF-211 Tomcats over California desert [Grumman]



VF-213 Tomcats sport medium blue tail markings, with yellow stars, twin tailed "Naturally!" Black Lion with yellow mane (squadron namesake) [Scott Brown]



F-14's of VF-114 These are all block ninety-five airplanes and are configured for Sparrow Missiles on fuselage, and two Sidewinders on each of the pylons "Boattail" between exhausts is tipped with navigation light [white], and fuel dump mast Light area on vertical fin tips [outboard both sides] is low light level formation light, which are also carried on fuselage, just ahead of turbine warning stripe, above "NAVY", and on nose, just above M-61 cannon fairing These lights are now common to most fighter aircraft of both services [Scott Brown]



A Tale of Two Tails...or... I Fly the Tomcat



You're too slow. Too much sink! Pullup. Pullup. Too a/c. I heaved back on the stick and added power. Then everything stopped. I had just staggered in the F-14. But what I owed was not a journey through diaphanous mists to the great beyond. Instead a voice sounded in my headset. Open the canopy Lou and let someone else have a go at it. More than a little sheepish I popped the canopy of the F-14 and looked up at Lt. Dave Davis, who was grinning down at me from the platform of the F-14 simulator dome at NAS Oceana. I had just spent a half an hour trying to fly the best fighter that has ever been built and I had made a Water Mitty shattering discovery. Seven hundred hours in assorted lightplanes does not a fighter pilot make. I hoped I would do better from the back seat because tomorrow was going to be flying the real thing and the F-14 is definitely a two man airplane. You can't get the Tomcat out of the chocks without the Naval Flight Officer who sits behind the pilot.

Earlier in the day I had spent an hour and a half in the rear seat simulator learning the position of switches and the proper sequence in which to punch them. That time coupled with some intense cramming with the manuals whenever I got the chance would suffice to get us airborne. But a final encompassed was turning on the radios, comparing the on board checks and alignment of the natural navigation system. We hardly even scratched the surface when it came to operating the complex weapons system of the F-14. And that weapons system is at the heart of the Tomcat's and spewed in my eyes the Champ of Fighter Of All Time. The well trained NFO is more than just another set of eyes in the F-14. He is half of the team that makes the Tomcat what it is and the Navy a completely solid on the two man fighter concept.

Briefing for the flight was scheduled for 1045. I arrived an hour early. (More study of the large chart containing the rear seat panel and consoles. The troops at VF 101's F-14 component were enthusiastic about making a new convert to the Tomcat fan club and they kept telling me how much was going to enjoy myself on the hop. My anticipation matched the enthusiasm and a nice they are all experienced fighter pilots with time. Heavily fighter the Navy has operated in the past decade. I was prepared to be impressed.

Lt. Joe Reeves was my pilot. We would be leading a two plane section. Proving the other F-14 was Capt. Jammer. Afshar of the Imperial Iranian Air Force. VF 101 is tasked with training many of the Iranian pilots who will return to Iran as instructors on their new Tomcats. This was to be Afshar's third hop in the F-14 and his first formation flight. The Iranians now going through the

F-14A of VF-101 "Grim Reapers" approaching NAS Oceana for landing. VF-101 was the first East Coast Tomcat Squadron and serves as the Atlantic Fleet replacement training component on the F-14. [Jim Sullivan]

F-14 syllabus are some of the best in the Shah's Air Force, with hundreds of hours in the F-4. Afshar's NFO was Lt. Barry Recame, a solo VF 101 instructor.

Lt. Reeves conducted the briefing, which consisted in the main of format on flying techniques in the F-14. He told Afshar to use the ejection seat warning triangle below the rear cockpit as a visual cue, keeping it just under the leading edge of the intake to maintain the proper format on position. He also warned Afshar about getting sucked in by the lead F-14's bow wave if that happens, he said, don't try to slide out by lifting a wing as you exit. Fly stick your wing into my belly. Put the nose down, get some vertical separation, then use adder to slide out. He went through hand signals used to command gear down, "flaps down", speed brakes out, then explained the F-14's characteristics in that configuration. He completed the briefing with the amusingly uttered admonishment, Fly safe Jammer. I've never had a midair yet!! (I heartily concurred with his sentiments.)

Dressing up for the role of a fighter pilot is an experience no pilot should be denied. In my case, I was like putting back stripes on a yellow housecoat. First the G suit wraps around your waist zipping up the sides, then you hold your breath, bend down, and zip the leggings up the inseam of your legs. If experienced fighter pilots can actually carry on a conversation while doing this, I'm like Clark Kent and couldn't imagine him talking to Lois Lane while he got his fighter pilot suit on. Next, you step into the torso harness which will attach your parachute harness, should the need arise. (Koch! It fits on the harness snap to seat belt and parachute risers in the airplane. Now your strap-leg restraints on your calves. They will snap to fittings on the seat, which will yank your legs back tight against the seat during the ejection sequence. This will ensure you of taking your legs with you if you eject! Finally, you are ready to strap into, zip up, and snap together your survival vest which contains such goodies as flare gun, knife, strobe light, water bottle, razor cutters, survival radio, and combination flare and smoke signal. He met in hand, knee board under arm, and we are ready to head for the airplane.

Much of what happens on a fighter flightline is performed by rote. The obvious reasons for this are the fact that it is too noisy to be doing a lot of

training and if you don't know your job well enough to perform it with a minimum of conversation, you probably won't be on the flightline long. I've put our helmets on before the walk out to the airplane, so I was able to drink and savor this moment in the sun. It was a gorgeous day and I participated, rather than spectator, for a change.

While Joe Reeves performed his walkaround, I climbed into the rear seat plane captain followed me up the ladder, and assisted me in finding and engaging all of the straps, lap belt, parachute risers, leg restraints, oxygen mask, G Suit, and communication cord were all in place. Joe leaned into the cockpit to tell me to arm the ejection seat. There are two methods of arming the ejection seat and both of them must be armed before you can use the seat. Since the sea has zero speed and zero attitude capability, I'm armed before you start. The firing handle between your legs has a safety lever that must be rotated to the "off" and down, and the face curtain handles are armed with a smaller lever behind and over your head.

Now that I was settled into the cockpit, I began to look for a place to put my camera so that I could use both hands to perform my duties in getting us underway. The cockpit is a tight space, a functional place, and there is not a lot of room for extraneous materials. I finally found a spot at the far left rear corner of the cockpit, on the left console.

While Joe was "trapping in," I began to check switch positions. Let's see now, start on the left console. Radio is ON, TACAN is OFF, AWW-9 liquid cockpit switch is OFF. Now in to the panel. Ground test panel is covered. Nav mode switch is OFF, AWW-9 power, hummm, oh yeah, this is right in front of the radar control handle. O.K. that's off, and the IFF (Transponder to you civilians) got to reach to the right and back to get that one, and it's off.

Joe is in now, and comes up on the intercom. "How do you read me, Lou?" I punch the ICS Inter Com Switch button on the floor with my left foot. Loud and clear. O.K. canopy is coming closed, keep clear of the rails. The canopy has a two foot clearance, I glanced over to make sure I was in forward the last couple of inches. Looking into place.

You might think that things would quiet down considerably with the outside world now shut out by Plexiglas. Not so. The F-14 cockpit is a relatively noisy place, though not uncomfortably so, and I have to think that there is a measure of security in being able to hear and judge engine noise.

Joe is in the ICS again, telling me that he is arming the engines. There is a series of flashing lights, and the cockpit begins to pressurize. My ears had to tell me things are happening, and I'm glad I don't have the mask on yet. I can still yawn to clear them. The plane captain is stationed up to the front cockpit and he goes through various stages of the start procedure progress. With both engines running, Joe does his check of the emergency generator. His notification that the check is complete is my signal to spring into action. It is time for my sole mandatory contribution to the flight.

Reach to my left on the console and push the eject command lever forward to the "pl of" position. (If that decision has to be made, it won't be me that's making it. Now the AWW-9 liquid cockpit switch to the rear, where the AWW-9 power switch is pushed forward to the stand-by position on TACAN and Rad o are both in the pit and they are switched on. The FF is on the right and I'm still in the stand-by position. Now for the On Board Checks. OBC. Joe comes on the ICS to tell me he has selected OBC, and I can proceed with the On Board Checks. Rotate the category knob on the console mounted keyboard to Spec a, then punch the OBC button. Instantly the radar screen in front

Tomcat Mechanic's Patch

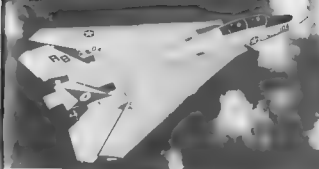


of me comes alive with a column of four acronyms as the computer interrogates the systems and checks on their well-being. (Any faults it finds are reported below the four columns of acronyms.) With the OBC test complete, I hit the alt key for the correct setting. Now for the present of the inertial navigation system.

I reach up and switch the Nav Mode to ground, then turn the category switch on the keyboard pane to Nav. Consulting the instrument and the keyboard, I punch in LAT latitude N&E 3 6 4 8 9. I appears in the Tactics Information Display TID Radar screen in front of me. As yet, I have the correct information entered, punch the ENTER button. I must punch LONGitude E&W 7 6 0 2 1, check the print out accuracy, and again hit the ENTER button. The Tactics Information Display screen in front of me now has the fresh vertical numbers displayed. The TID screen within 20 seconds a check mark appears at the extreme left of the screen and begins to move across the screen. At this point, three lights appear on the panel. The NAV COMP in the right knee pane, and the STR and READY lights on the panel all flash at the TID pane. As the alignment of the Inertial Navigation System (INS) continues, they will extinguish to indicate progress towards readiness. If the system On the TID the check mark passes the first vertical line at the end of a half minute, the alignment is a diamond. This indicates alignment with designated accuracy and is accompanied by the NAV COMP lighting up. At four minutes, the alignment is a diamond has progressed, and the second vertical mark and we would now be able to leave the line assured to accuracy within 4.5 nautical miles in an hour. The final alignment of the system takes an hour and a half minutes, and gives us accuracy to within .75 nautical miles in an hour.

At this point, a real NFO would enter his waypoint data, perform the TACAN BIT, then switch the NAV Mode to INS. Since I am about six months short of NFO training, I content myself with performing the last function. The INS will now give us continuous readouts on our position as the flight progresses.

With alignment of the INS complete, Joe comes on the ICS to tell me that we can complete the BIT checks. Our wingman has boarded ten minutes after us, and I'm thankful that I have plenty of time to consult the checklists on my kneeboard. Rotate the category button back to BIT, and punch the upper left button on the keyboard. A little green arrow appears to tell me now I have punched it, and the TID displays a box in the upper center of the screen. When



Tomcats of VF-14 "Tophatters." In photo at left, inlet bleed air doors are prominently displayed on top of wing gloves, just behind ECS heat exchanger outlets (darker area). Note single walk area painted on top of port intake. Tomcat above has Phoenix pylon under wing glove area and carries special multi-purpose pallets under fuselage (US Navy & Bob Lawson & Jim Sullivan)

a check mark appears at the lower left corner of the box. We know that BIT is complete. If any discrepancies are found, the computer will print them out on the bottom of the screen. The crew will now know if they have to fly the mission with a degraded system and which parts of the system are nonoperative. We complete BIT 1 and BIT 2 in the checks. BIT 3 involves turning the radar transmitter on, and since its transmissions could be harmful to any ground crewman standing in front of the airplane, it is usually done while taxiing to the runway.

With the checks complete, Joe gives a thumbs up to the plane captain, and he waves us out of our parking spot. We taxi to the end of the line, stop, and Joe kneels. The airplane drops for final checks by the ground crew. In this respect the F-14 is just the opposite of the F-4. Whereas with the F-4 the nose is raised for a catapult to give maximum angle of attack, and after maximum lift at the end of the cat, the Tomcat's nose is depressed so that the catapult launch bar can be attached to the catapult shuttle. The ground crewmen perform final checks and with a smart salute, we are waved onto the tarmac.

The Tomcat is like other carrier aircraft I have ridden in on the ground. It rides hard. Each bump and crack in the pavement is telegraphed right to the seat of your pants, and I can see how the landing gear would survive 25 foot per second smashes onto the deck. This is not the normal rate of descent, but it is what the Navy had specified for the gear, and during testing the gear proved to be stronger than the test pilot who was testing it and put himself into the hospital with a severe back compression.

Approaching the end of runway 32, we swing around to runway heading for final checks. I ask Joe if he wants me to read the check list. He replies that he will read it aloud, both challenge and response, and the following itinerary comes over the ICS: Brakes OK, accumulator pressure up, fuel normal, feed auto trans, dumps off, 16,000 pounds showing on the counter, extend trans checked, canopy handle used, hooks engaged, lines check OK, right oil, Seat armed forward, pilot in window, is your command lever forward? "right!" OK, SAS switches, all on, all circuit breakers in master test, off, B-directional pump normal, Compass and standby gyro compass synched,

standby gyro erect. I watch a couple of A-6s in the touch and go pattern come in, touch down, then rotate into the air again immediately. Two F-4s from VF-11 pull up next to us to do their preflight checks. Finally our wingman taxis into position for his last minute checks. The tower clears our flight. Gunfighter 153 and 174 into position on the runway.

A nudge of the throttles engages nosewheel steering, push the rudder pedals, and we bump onto the runway. I bring up to the right of the center line. Our wingman follows, lining up to the left and behind us. Time now for the final pre-taxi-off checks, and Joe is on the ICS again. "Wings 20 degrees up, both lights out, check them visually, and they are at 20 degrees. Flaps and slats indicate down and they are. Spoilers outboard spoiler mod on, speed brake select spoilers up, check them, and they are up, speed brake off. Check trim neutral, harness hooked, got yours locked? right. Check controls. OK, check warning lights, all out, are yours a cut? right. OK, I see we're ready to roll, and as soon as we get a thumbs up from Jammer, we'll be rolling."

We are both looking over our left shoulders now, watching for the thumbs up that will indicate that our wingman is ready to follow us. When Jammer sees the brakes, goes to zone two afterburner, then releases the brakes.

The F-14 leaps forward, then Joe goes to zone five afterburner, and there is another slam in the back. I have never felt this kind of acceleration in an airplane. Experimentally, I try to lean forward into it. I can't! Somewhat sheepishly, I remember that my harness is locked. Still, I doubt that I could overcome the inertia being generated by better than 40,000 pounds of thrust from those twin TF-30s behind us. I dart a quick look at the speedometer, better than 100 knots already. The needle seems to surge through 120 knots, and we are airborne. Less than 1500 feet of runway are behind us, and we are climbing rapidly. Gear is up, then in seconds, we are level at 1,000 feet, and the flaps are coming up. Joe banks left, and I look back to see Jammer cutting no more on up.

Steady now, on course 160, we have gotten departure control clearance for a Tidewater one departure. Alfalfa is tucked in on our right wing, and I am



beginning to appreciate two highly fouled features of the forecast: The visibility is great out of the bubble canopy, and it is a comfortable airplane. In the Phantom, you're already being fidgeted around trying to find a more comfortable position. Carter has cleared us to 15,000 and as we've left Barry calls for us to go high to loom at 10,000. A longshot is the idea of a leader who will oversee activities in the restricted airspace afforded to the military. Barry calls us high to let us advise them of our intended activities and then, let us know that there is ACM activity in the S where sector Barry says is a detour. Then we will stay north. Alpha has stayed good. I am going to turn through, and from what I can see he is doing a great job. Once a trust he is 174 and in a little so you can get a taste of that bow wave I was telling you about. Summer begins to disappear behind our starboard intake and begin to fidget. Suddenly he pops back out over and farther behind Barry calls. He handed it over to us. Now we will separate to give Alpha a chance at some business.

Joe banks left and pulls in and suddenly, I see the G50 sequencing. How many G's was that Joe? Oh about two and a half, maybe three. I feel like four or five. I'm thinking to myself and resolve to lighten up a little on the next one. We go about two or three miles separate now and Joe runs a cut and looks back. Althar's coming up on the left side but Joe is prattling eye he's a little far back. He's too far back, sucked out there, that's better. Gunt Gunt 174's idea is in the first G Joe's OK 174 isn't there in the night. The buoy isn't 90 degrees and we pull around to the right. This time, I'm ready and the G's are more comfortable. Looking back, there's light we can see 174 we cut to the side and pull our circle nicely. A much better turn, up this time and Joe is satisfied with Jammer's performance to the right but wants to try another to the left. We bank hard left again and I'm really starting to enjoy the responsiveness of the Tomcat. There's just something about the way a higher handles. You can feel the power and arm/struck again by the feeling of a mass freedom, but the best is yet to come. After Althar joins up, we go through pulling the gear, flaps, and speed brakes down 174

ing retains his relative position throughout and I am impressed that the soft spoken rahian is a hell of a pilot (remember this is on y his third hop in the F-14, and his first format on flight) or the F-14 is a pussycat to fly in format on. After my experience in the simulator I would prefer to believe the former!

10 Sat stated that we have accomplished the formation training portion of our mission. Joe calls Longshot Control to ask if they have contact with the Fast Eagle. Fast Eagle is a flight of two F-14s from VF 4. They are brand new, black ninety five Tomcats. The first 2 airplanes the Black Aces have never seen, and they have agreed to fly formation on in for the benefit of my name. The Fast Eagles are not yet so Joe shows me some of the things a 4.5 Combat Maneuvering (CM) capabilities by pulling away from Alpha, then coming up and is our wingman. It was not until the obvious energy is shed which I am clearly aware of is necessary to safety. I cannot say I am not using these maneuvres the ease with which the F-14 gets up a speed of 10,000 ft/min and laterally would seem to be the ask demanded. It is a high speed, high altitude, but the F-14 has crossed a technological threshold, not only in terms of its imaging weapons systems, but perhaps more importantly, the energy of the fighter pilot. As an example, I have experienced it as generated by high energy fighter aircraft before in the F-4 and F-105, an abrupt experience the qualities that make the Tomcat truly unique.

[illegible]

May 4 item stated the method of shaking a potter's wheel can drop to 20,000 feet a minute state the doctor of this latest Guinness (at over a 20,000 rpm rate) says he comes back on the stick with only 100 rpm. We have achieved 85 degrees of pitch up. The climb is measured at 1500 ft per minute rate of about 6,000 feet per minute. Then as the energy is dissipated the rate of climb drops and the speed goes to 100 ft per minute. In the advertised slip speed 110 knots and beyond to 200 ft per minute. We have defeated gravity and are really hanging suspended in the air with our nose pointed straight up. But gravity is an adversary that can't be fooled. We are now sliding back down at the rate 19,000 feet per minute. In a few seconds, the plane will have to come back to the ground. We are slashing pitch down again. The forward rate is never as gentle. It is a nose dive. www.vivaworlds.com picking up speed as it goes as it is were alive and searching for the speed needed to negate that and end our 9,000 foot per minute fall. Throughout this maneuver it remains the up time of a constant rate to exhibit the nasty tendencies many of us



Tomcat of VF-142 "Ghostriders" refuelling from KA-6 Tanker of VA-176 over the Mediterranean. USS America steams in the background. During 1976 deployment, VF-142 averaged 18 sorties per day, each of approximately two hours duration. [US Navy]



VF-142 Tomcat, with Sparrow and Sidewinder launch rails under wing glove. [Bruce Trombecky via Jim Sullivan]

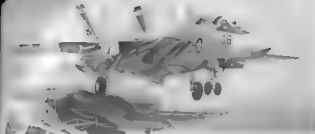
One of the most dramatic moments in Naval Aviation... night launch! [US Navy]

Prototype Infrared Sensor



ALQ-100 Antenna





VF-143 "Pukin' Dogs" Tomcat leaves the waist cat of USS American during 1978 Mediterranean Sea cruise. F-14s speed at end of catapult is 145 knots [US Navy]

VF-143 Tomcats with wings fully forward. Sweep angles of 20 degrees through 75 degrees result in wing span variation of 33 to 64 feet. [US Navy]



contemporaries would throw at you, such as a spin. Not only has the airframe behaved in an exemplary manner, but the turbofan engines have refused to stall it to boot! Just to prove that there was nothing extraordinary about this maneuver (for the Tomcat) Joe repeats it with one exception. This time he saves enough travel on the stick to give a healthy yank rearward as we approach zero airspeed.

The result is practically the same, except that the pitch down is slightly more pronounced. The nose goes straight down, ninety degrees, and as soon as we have a speed, he pulls it out. This is a one behavioral aspect of the F-14 that was not anticipated by Grumman, and is the apparent result of the wide, flat fuselage acting as a lifting body. This inherent honesty, coupled with automatic wing sweep scheduling and the heads-up display, makes the F-14 the best dogfighting, air superiority fighter ever built. Throw in the NFO

with the AEWG weapons system and Phoenix Missiles, and you have the best interceptor ever built. So what we have here is the best pure air fighting machine ever. And it is being improved during production.

Block ninety and upward F-14's will have automatic leading edge maneuvering slats, a new central air data computer, and a new GHF radio. The maneuvering slats are programmed to pop out at 13 units angle of attack, and retract at 11 units AOA. The slats have solved one annoying characteristic of the Tomcat, which was demonstrated to me. At 12 to 14 units AOA, there is the onset of buffet, which remains until you ease off to lower AOA. Looking in the mirror during this maneuver was horrid to see the twin tail's wagging like a happy dog's. The buffet does not signify the onset of any drastic or unplanned maneuver though, and the AOA can be flown right up to 30 units initial stall angle of the automatic slats though. This has resulted in an increase of 1/2 to 1 more G in sustained turning performance.

It doesn't take much imagination to figure out what this means to the young, low time fighter pilot. He can now reach for that ragged edge that is required to turn ordinary fighter pilots into world-beaters, and do so with more confidence. It means that the U.S. Navy will have a fighter force that is second to none in the world, and cost and time required to train that force is drastically cut.

Our rendezvous with Fast Eagle for picture taking seems sort of anticlimactic now, except that I am now more impressed than ever with the breathtaking beauty of these two sleek juggernauts as we dart from right to left, over and under them while I snap away the film. One pass over Oceana with VF-14's Tomcats in light wings fully swept-forward, and we break off to enter the pattern.

If there is one maneuver universally enjoyed by all fighter pilots and would-be fighter pilots (I do it all the time in my T-34) it is the break from initial to downwind leg of the traffic pattern. We roared down the duty runway at 300 knots, 800 feet above the runway, then we cranked into a 60 degree screaming bank to the left. He switched to hot mike and read the checklist as he accomplished each of the items: Wings, 20 degrees auto; Wheels, three down; Flaps, full down; Hook, is up; Harness, locked; got your's hooked? "Rog." Good. O.K. Speed brakes out.

At the 180 degree abeam position he has the airplane trimmed at 15 units AOA, DLC and APC (Direct Lift II Control and Approach Power Compensator) are on. I am surprised at how tight the pattern appears to be. I have seen a lot of guys fly wider patterns in the F-172's, but then the Navy does not like to dawdle around when recovering a rollout aboard ship, and I guess that Navy pilots are taught to get it on right now. I have a few seen guys ease up a bit and get that they have worked on for five minutes. We rolled out on final with an "on speed" approach, indexes indicated on, and maintained our 15 units right down to the deck. As soon as the main gear struts compressed, Joe pushed the throttles forward to full power, and we leapt off in runway on our go-around. No matter how many lighter types fly in, I am a ways most impressed with the excess power. We got to pattern altitude in what seemed like miliseconds, turned crosswind, then downwind, and re-read the checklist. The second and third go-around was full-stop, and as smooth as a carrier landing could possibly be. It's all over now, except for the taxi back to our parking spot, and am saddened. But I am so a man with a mission, I have become a certified convert. The Tomcat is everything they told me it would be, and then some!



[Left & Center Left] VF-84 "Jolt 9" Rogers Tomcat is one of the new block 95 airplanes. DECM RCVR antenna is carried on tip of starboard vertical fin. Area of tailpipes varies from 7.5 square feet full open (shown here), and 3.53 feet in closed position. Tailpipe nozzles are infinitely variable between these positions and open and close automatically in response to amount of thrust being generated by the engines. [Jim Sullivan]

Below Left] VF-84 will take it's Tomcats to sea on USS Nimitz. Tom Hayden]

VF-41 crew straps into one of their brand-new block 95 Tomcats. NAS Oceana April, 1977. [Author]





VF-41 has the only black-nosed Tomcats in the fleet. Black nose is a tradition with "Black Aces" fighters. Factory-fresh gull-grey finish on these Tomcats had a distinctive sheen to it. [Author]



DECM High Band antenna is contained in the boattell, next to fuel dump mast above, Jim Sullivan. VF-41 will operate from USS Nimitz when they go to sea.





VX-4 operates several Tomcats from their base at PMTC, Point Mugu, California. They are tasked with determining the full potential of the F-14 in the air superiority role (above) [Dr. C. Eddy via Norm Taylor]

Large bubble canopy of the Tomcat provides it's crew with first pre-requisite of the air-superiority machines...superior vision. [US Navy]

Latest version of the Tomcat formates on the number three airplane, which carries a pair of practice AIM-9 missiles. [Grumman]





Grumman's F-14 assembly line at Calverton. New Tomcats for Navy and Imperial Iranian Air Force are being completed. Iran will take delivery of 80 F-14s. [left] Completed Iranian Tomcat awaits delivery at Grumman plant. [below] First Tomcats were delivered to Iran on January 30, 1976. They are being produced at the rate of two per month. [Hans Redemann]





View of the F-14 that potential aggressor might expect to find in his rear-view mirror. The Tomcat is the first of the new generation of U.S. fighters, and it is as dominant in the worldwide fighter scenario as any of its predecessors in the famed Grumman "Iron Works" stable.

F-14A of VF-143 carried markings of CAG Commander Jim Lusk. It is loaded for optimum long range air superiority mission, with four Phoenix, two Sparrow, and two Sidewinder Missiles, plus two external fuel tanks.



F-14A of VF-142 gets the launch signal from the Catapult Officer aboard USS America.

Low Dreyer
9/11/88



Low Dreyer
9/11/88